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HELIKITE ELEVATED PLATFORM (HEP)
FINAL REPORT HEP PHASE I
SMALL BUSINESS INNOVATIVE RESEARCH (SBIR)
TOPIC A00-134

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TECHNICAL ABSTRACT

The Army requires a method of deploying a GPS Pseudolite to several hundred or thousand feet altitude to provide augmented GPS signals. To meet this need Carolina Unmanned Vehicles, Inc. is developing the Helikite Elevated Platform (HEP), consisting of a small tethered blimp mounted in a special Carrier that allows operation by a single person. It can be towed by a HMMWV or other small vehicle. HEP may also be used for Differential GPS support to enhance areas such as helicopter all weather navigation. Other payloads can include video cameras, COMINT / SIGINT receivers, jammers or communication equipment. The project will provide an improved capability for the military and civilian agencies for continuous low cost elevation of a variety of payloads to several thousand feet, with minimum manpower, training and investment.

HELIKITE ELEVATED PLATFORM (HEP)

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HELIKITE ELEVATED PLATFORM (HEP)

1.0 RESULTS OF THE PHASE I WORK Carolina Unmanned Vehicles is developing the **Helikite Elevated Platform (HEP)**, which consists of a new type of small specially designed tethered blimp, called a Helikite, and a vehicle mounted Carrier (Fig. 1). Designed to lift a GPS pseudolite payload, it is also suitable for a number of other missions. The Phase I work developed the Baseline design for both the Carrier and Helikite. Trade studies were used to refine the system technical requirements, size the components and select the most suitable Government Furnished Equipment for the trailer and generator.

1.1 HEP CONCEPT Many military navigation and weapons delivery systems are depended upon Global Positioning System (GPS) signal. Unfortunately, these signals can be degraded or jammed, so the Army is examining deployment of GPS pseudolites. Pseudolites are near terrestrial transmitters that emit GPS signals substantially stronger than that received from interference or jamming. Pseudolite navigation needs a line-of-sight to the receivers, requiring that the pseudolites be elevated several hundred meters above the ground to reach ground based receivers.

The HEP blimp can be flown at several hundred to a thousand meters altitude for low cost, long term pseudolite coverage of large areas. It consists of several unique components that, taken together, comprise a system far smaller and more versatile than any comparable unit. The blimp, a version of the patented Helikite, supports more payload for its size than any ordinary blimp. Furthermore, Helikite can operate in much higher winds than traditional blimp designs, improving system utility and capability in adverse weather. HEP will be very mobile and cost-effective through use of unique designs to reduce the need for ground crews to handle the blimp during launch and recovery. It is carried by a single trailer and can be readily operated by a single person. It can also be airlifted by aircraft or helicopter to forward sites and can provide coverage 24 hours a day for a week or more without maintenance or downtime.

HELIKITE ELEVATED PLATFORM

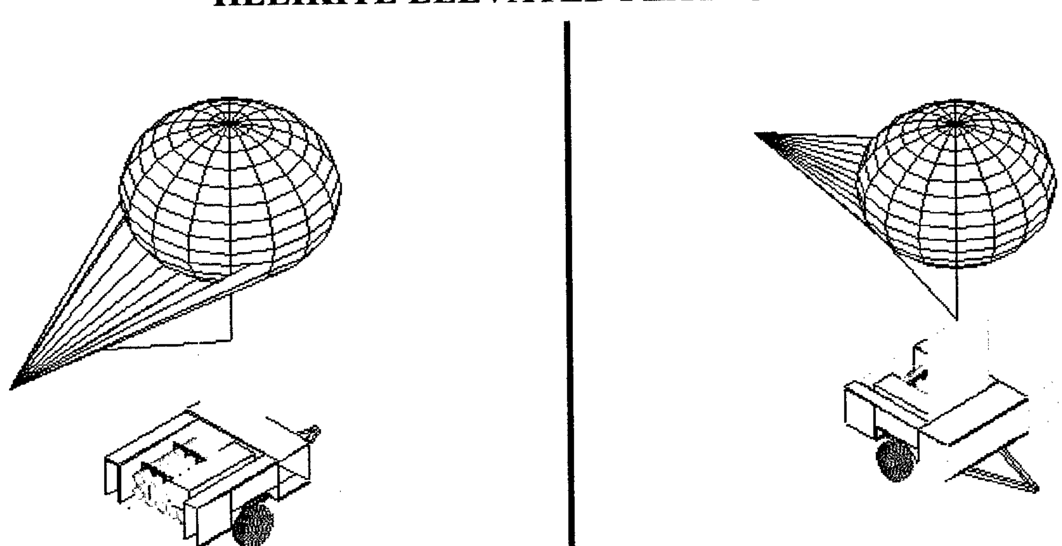


Fig. 1 HEP Provides An Inexpensive And Easy To Operate Method To Elevate Payloads For GPS Pseudolites And Other Missions. Very Mobile And Easy To Deploy By Air Or Ground Transport, HEP Can Remain Operational On Site For A Week Or More Without Downtime Or Maintenance.

1.2 HEP BASELINE SYSTEM DESCRIPTION A complete HEP system consists of a Helikite and a Carrier. The Carrier is mounted on a military standard trailer that can be towed by a HMMWV or small pick-up truck. HEP can be readily deployed by transport aircraft, helicopters, trucks and HMMWVs. The Helikite can be deployed directly from its Carrier by a two person crew, who simply open the Carrier top, lay out the Helikite, attach the inflation tube and open the helium inflation valve. Guide-rails on the Carrier restrain the inflated Helikite until it is launched, allowing one person operation even in high winds. The crew activates an onboard winch to allow the Helikite to rise to its operating altitude on the tether. The blimp can be easily retrieved and stored in its Carrier for movement to another location. The entire deployment can be accomplished in under thirty minutes. An onboard generator provides power to the payload and the winch.

The system requires almost no maintenance and can remain on station for weeks at a time. The only maintenance would be periodic reinflation of the Helikite due to long term helium leakage. This leakage is typically about 3 to 5 percent a week. In typical operations HEP should remain on station for a week or more without being retrieved and "topped-off" with helium.

1.2.1 HEP Operational Sequence In operation the HEP is towed by a HMMWV or other standard small military truck. The tow vehicle would move HEP to a suitable launch point, which primarily means a location away from tall trees, overhead power lines or other obstructions. The system is mobile enough to operate in the rear Divisional area, but would not normally operate further forward for survivability, safety and logistics reasons.

1.2.1.1 Carrier Launch Once on location the Carrier top is raised, and a valve is opened to feed helium from the tanks to a fitting on the Helikite keel. The blimp inflates while attached to the Carrier but is restrained from moving and being damaged by hitting its surroundings. When the Helikite is fully inflated the helium feed line is detached and the Helikite is ready to rise with the nose of the keel riding in a slot on the raised Carrier top. In this manner the Helikite can rise to height approximately 12 feet above the Carrier body before it is released to float freely on its tether. This positive control method is unique to the HEP design and greatly reduces the potential for damage to the Helikite as well as reducing the time and manpower to launch the vehicle.

1.2.1.2 Remote Launch If required because of overhead obstructions, very high winds or survivability concerns the Helikite can be deployed away from the Carrier. A metal screw similar to a dog chain restraint is provided attached to a special pulley. It can be screwed into the ground away from the Carrier and the adjacent ground covered by a tarpaulin. The tether line is then passed through the pulley and the uninflated Helikite laid on the tarpaulin. It is inflated with a flexible line from the Carrier tanks.

While the Helikite is still moored, the onboard generator is started and the payload is checked out. The winch is then released and the Helikite rises to its operating height. The only maintenance would be periodic reinflation of the Helikite, due to long term helium leakage, and whatever maintenance the payload requires. Once the Helikite is inflated the Carrier and tow vehicle can be moved some distance away for extra security if desired.

1.2.1.3 Retrieval During retrieval the winch pulls the Helikite down until the operator can reach the keel with a metal pole. The operator then uses the pole to guide the keel into the slot in the Carrier top. The blimp can then be pulled down the remaining distance by the winch, deflated and stowed. The Helikite is drawn down snug against the pulley if remote operation is being used, and the Helikite deflated and stowed The Carrier top and sides are folded down, sealing the blimp and payload inside the protective cover. The tow vehicle can then move the HEP to a new operating location.

The most dangerous portion of blimp retrieval is at a height of 30 to 50 meters, where swirling winds around trees and building can deflect the blimp into obstacles and damage the it. Because of the lifting wings, the Helikite can be safely retrieved by winching it down quickly. Drawing the Helikite down

quickly creates a relative wind that generates lift on the wings. This lift stabilizes the Helikite and causes it to come nearly straight down even in strong crosswinds.

HELIKITE

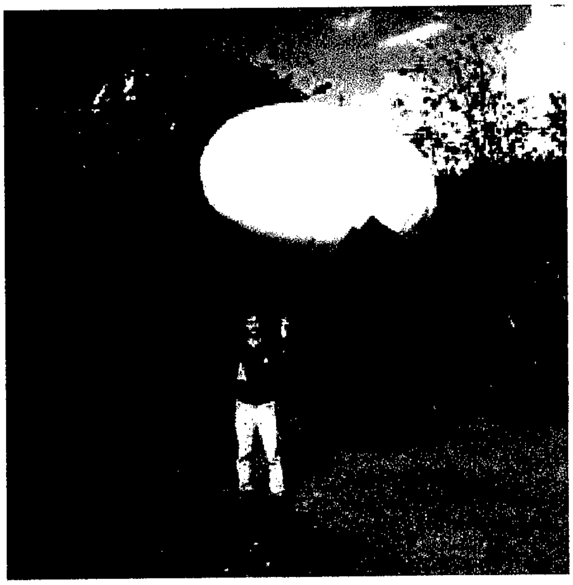


Fig. 2 HELIKITE The patented Helikite uses fabric wings to provide a force to counteract wind drag, reducing the size required for stability in wind. This allows the overall size of the HEP to be significantly smaller than any comparable system.

1.2.2 Helikite The keys to making HEP a very compact but versatile system is the Helikite (Fig. 2). Develop and patented by Allsopp Helikites Ltd. of Great Britain, Helikites are a unique combination of a kite and a blimp. As such, they employ the advantages of both without incurring too much of their disadvantages. The Helikite employs small flexible fabric wings and keel attached to the body of a helium balloon. The revolutionary Helikite aerostat uses a combination of both helium and wind to provide exceptionally reliable lifting up to 2000 meters. It can operate easily in high wind speeds and at a fraction of the cost and trouble of other methods and using minimal helium compared to normal lighter-than-air designs.

1.2.2.1 Helikite Design Why does this Helikite design make a difference? An ordinary balloon or blimp in zero wind will float straight up from its tether location. The helium exerts an upward force and the tether an equal downward force. However, the tether cannot exert a sideward force to counteract wind forces on the balloon. In wind the balloon is driven sideways until the angle of the tether allows the upward buoyant force to match the side wind forces (Fig. 3). The side force is the buoyancy times the sine of the angle between the tether and vertical. For small angles the sine is small, allowing a balloon to deflect to a considerable angle before the wind force is balanced.

The normal method to counteract wind forces and keep blimps stable over their launch point is to increase the buoyant force significantly beyond that required to lift the blimp and payload. With a larger buoyant force, the sine of even a small angle is sufficient to counteract the wind drag. However, greater buoyancy requires a significantly larger blimp, resulting in greater cost, difficulty in ground handling and often additional personnel. It is a limited solution in any event. Wind drag increases with the square of the wind speed, so very large forces can be created at medium winds.

The Helikite is lighter-than-air like a balloon but does not get knocked down by the wind like a normal balloon. In fact, normal winds do the opposite to a Helikite - they actually force it up! The HEP Helikites will be able to fly in winds up to 70 mph and still be manageable by very few personnel. Wind forces on the wings and the airfoil shaped balloon generate a force that maintains both the blimp body and Helikite wings at an angle of attack that generates additional lift to counteract the wind side force. Helikites have a lift to drag (L/D) ratio of approximately one. This means that even in very high winds they stabilize with their tether at approximately 45 degrees from the vertical. With this lift force to counteract the wind drag the Helikite does not need a large buoyancy margin and can be less than half the size of normal blimps.

The Helikite design is also far more intrinsically stable than traditional blimp designs. The reasons for this are explained in Figure 3. Helikite performance is the key that allows HEP to be very compact, use minimum helium and be operable by only one person.

WIND EFFECTS ON BLIMP STABILITY

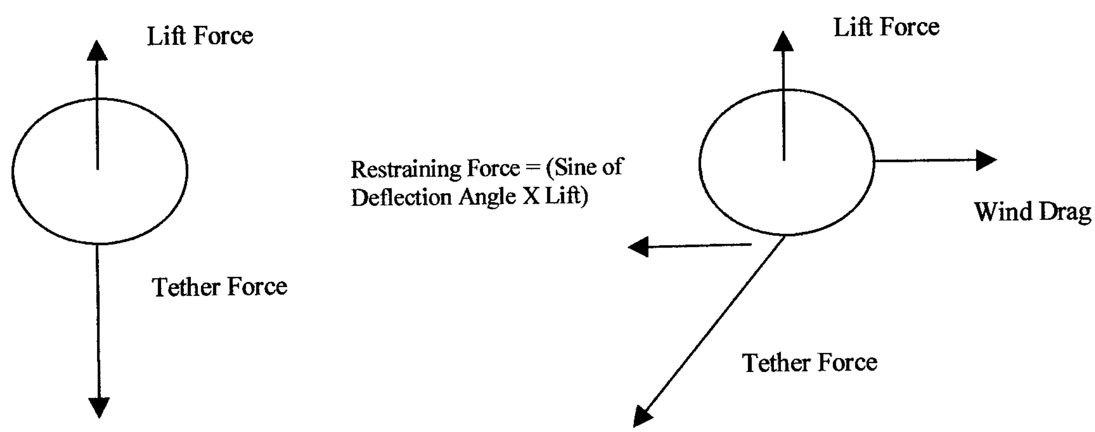


Fig. 3 Traditional Blimp Stability Because the only force to oppose wind drag is the lift times the sine of the deflection angle, a tethered blimp normally requires much larger lift force than its payload to prevent it from being driven into the ground by wind drag. This requires a blimp to be larger, increases cost and ground handling personnel / equipment. The patented Helikite proposed for HEP uses wing lift to counteract wind drag, so it can be much smaller, reducing personnel and logistics requirements.

1.2.2.2 Current Operations Helikites have been used as an elevated platform for communications and surveillance as well as platform for sensor research. They have demonstrated the stability necessary for video surveillance and continuous operation in winds. Particularly noteworthy is current use by the British Antarctic Survey, where they have been described as "working brilliantly", producing excellent data due to their steadiness. Operation at –20 ° Celsius has presented no problems and new materials with excellent helium holding properties have recently been tested successfully down to –55 ° Celsius.

Two 11 m^3 Helikites are being used to measure wind speed at La Courte Orielles Ojibya Community College in Minnesota, under NASA funding. This project is designed to hold wind speed meters aloft to determine the best place for a wind farm. The wind meters are held level at two points on the line using two Allsopp Stabilizer Fins. The Helikites have a pure lift capability of 6 Kg in no wind and about 20 Kg in a breeze. They use a solar powered ground station and are designed to withstand Minnesota's bad weather for long periods of time unattended.

1.2.2.3 Helikite Materials The focus of the Phase I work was on materials and fabrication techniques for the HEP requirements. The construction of Helikites is dependent upon the correct use of the best materials that are suitable for the particular purpose for which each Helikite is designed. Helikites require a helium holding balloon, a kite sail, a spar and a method of attaching these three elements together so they can withstand high winds.

Helium is a very tiny molecule and is able to permeate most materials. There are few flexible, easy to work and lightweight materials that can hold helium for a useful length of time. There are even fewer that are transparent and water repellent.

The manufacture of film and fabric is a massive business with many trade secrets regarding the exact makeup and manufacture of the materials, so obtaining reliable information is far harder than might otherwise be the case. Further, manufacturers concentrate on properties for the high volume packaging industry. They are not concerned about helium retention or other balloon related properties. In many cases we must obtain samples and conduct our own analysis of material properties.

1.2.2.3.1 Required Materials Properties A Helikite for HEP requires a number of properties, including:

Good Helium Retention (Balloon only)

Flexible

Lightweight

Easy to work

Transparent

Available in required quantities and widths

Different materials are suitable for the balloon and kite. A number of materials we have investigated are discussed below, with comments regarding their suitability for Helikites in general and HEP in particular.

1.2.2.3.2 Balloon Materials

Polyester	Brittle, light, transparent. Not so good at holding helium as when it is metallised.
Metallised Polyester	Light and holds helium well. brittle, punctures. Maximum width 36 inches. Not transparent, reflects sunlight.
Scrimmed Polyester	Good at holding helium, strong, clear. However, very hard to seal.
Polythene	Cheap, easily available in very wide widths, clear, silent, keeps its structure despite vibration and flapping. weak, stretches, does not hold helium well unless very thick.
Polyethylene	Soft, weak, light, very easy to seal. does not hold helium well.
PVA	Strong, holds helium well, easy to work, dissolves in water in seconds. Possibly could be used as an inner layer. Definitely worth investigating further.
Metallised Nylon	Holds helium well, strong. Limited to 36 inches wide. Not transparent. We produce thousands of these balloons for our "pocket helikites".
Polyurethane	Strong with some useful stretch, good helium holding, easy to seal, available in many colors including translucent. Most sky-hook helikites are made from this material. Slightly too heavy and soft. Goes yellow in sunlight.
Nylon/EVOH/ Nylon Laminate	The perfect balloon material, strong, light, excellent helium holding, transparent. Hard to seal without a heat sealer. Very hard to make. Comes only in 12 inch widths from Japan. Minimum order, $30,000.
EVOH/Polyethylene	Cheap, light, probably strong as polyurethane excellent helium holding. Easy to work. Not yet commercially available. A future possibility.
Ripstop-Nylon/ Polyurethane Mix	Strong, good handling. still rips too easily, slightly heavy, difficult to seal and to make good round balloons.

1.2.2.3.3 Kite Materials

Ripstop-Nylon	Excellent kite material. Strong, light, cheap, many colors. Slippery to work with, so skilled kite makers needed. Maximum width 54 inches. Not transparent. Vulnerable to UV light. Noisy. Most Helikites are made with Ripstop-Nylon.
Polythene	Transparent, cheap, resilient, available in massive widths. It stretches. No good glues yet found for it. Hot glue will melt it. Hard to work with and fix to balloon. The HEP concept Helikite is made with Polythene.
Polyurethane	Translucent, easy to glue, cheap. Slightly weaker than Polythene. Far weaker than Ripstop-Nylon. Possible material with supporting lines.
High Density	
Polyethylene	Excellent material. Light, strong, wide widths, many colors. Not transparent.
Tarpaulin	Cheap, easily available in huge widths, strong, average weight, easy to work with. Not transparent. Noisy.
Cotton	Easy to work with, cheap, many colors. Traditional material. Biodegradable. Heavy. Absorbs water.
Scrimmed Polyester	Light, almost transparent, strong, rip-stop characteristics, can be sewn. Hard to obtain, brittle, noisy, expensive. Can cut into soft balloons if it is not edged carefully. Likely to be the best compromise for making a stealthy, light, strong kite.

1.2.2.3.4 Spar Materials

Carbon Fiber	excellent. Strong, light, stiff, easy to work with. Expensive. Need gloves to work it. All Helikites use carbon-fiber.
Glass-fiber	strong, easy to work. Too flexible and heavy. Need gloves to work it.
Aluminum	Light, cheap, easy to work. Breaks without warning. Reflects radar. Worth a look for economical large Helikites.
Wood	Stiff, cheap, easily available, easy to work. Slightly heavy but useful. Biodegradable.
Bamboo	Light, cheap. Traditional material. Works well. Biodegradable. Hard to obtain in the correct grade. Breaks without warning,

1.2.2.3.5 Fixing Materials and Methods

Sewing	Light, strong, flexible. Most Helikites are sewn out of rip-stop nylon. Skilled workers needed, especially for larger Helikites. Very difficult to find such workers with the correct heavyweight machines. Very difficult to sew large areas of cloth for very large Helikites. Some sheet materials rip when stitched.
Contact Adhesive	Sticks kite to balloon on most Skyhook Helikites. Excellent strength. Very reliable. Toluene fumes a big problem. Hard to apply.
Spray adhesives	Easy to apply. No bad fumes. Not so strong.
Hot glue	Good for Polythene. HEP Helikite made this way. No fumes. Very slow and labor intensive. Burns danger. Hard to do well.

Strapping	Strong, stealthy, no fumes lightweight. Enables weak materials to be used for the kite. Balloon can be exchanged easily. Strong-points need to be carefully arranged. Not so simple to set up.
Bolting	Strong, simple. Danger of puncturing balloon with anything metal. Slow to deploy if used extensively.

1.2.2.4 HEP Helikite Baseline HEP uses an elliptical Helikite design with the lower keel to provide a support point for the Helikite during deployment and retrieval, making it easier to operate by one person. Nominally, a Helikite has a helium lift of one kilogram per meter cubed of helium. For small Helikites approximately 40% of the lift is required to support the Helikite itself. An additional 10% design allowance is made for operation in low air density, i.e. hot and/or high altitude conditions. Thus the designer normally estimates 0.5 Kg of lift for each cubic meter of helium.

Initially we anticipated HEP could be designed with less than a 50% reduction in lift margin, since we are using a larger Helikite. Displacement volume increases as the cube of the diameter while surface area, and therefore fabric weight, increases only as the square of the diameter. Therefore, a larger unit is more structurally efficient. However, HEP is a military system that will be operated in adverse environments worldwide. We therefore decide to retain the 50% design rule for conservatism.

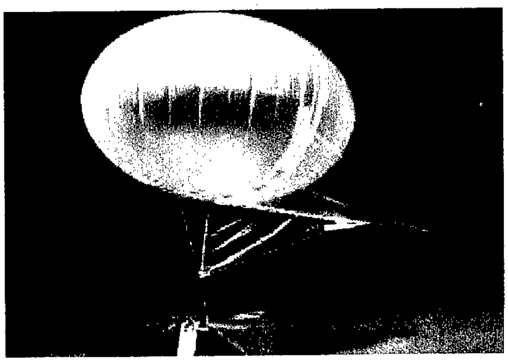
To lift the required 25 Kg (55 lb.) psuedolite payload will require a Helikite volume of 50 meters cubed. Compared to any other tethered blimp systems capable of lifting 25 Kg to 600 meters (2000 feet) the HEP blimp is very small, with a balloon diameter of approximately 5 meters (15 feet) and total length of 6.5 meters (20 feet). For comparison, Allsopp Helikites requested a quote from a major international balloon maker for a conventional blimp to lift 25 kg in winds up to 50 mph at 2000 ft. Their approach entailed using a 700 cubic meter (24,500 cu ft) barrage balloon shaped blimp costing £45,000 ($64,350). It would entail a massive ground logistics effort compared to the Helikite and be quite impractical for mobile operations. The strain on the tether line in high winds would probably require a concrete embedded winch.

We are still researching materials and believe we can achieve a much better weight efficiency than the 50% used in our current estimates. The 50% lift reduction discussed above is a conservative empirical rule based upon testing of smaller Helikites. The largest Helikite built to date is 20 m^3. The actual lift we can achieve will depend upon the materials we are able to use for the larger unit. To reduce the visible signature we are designing a transparent Helikite using 6 mil thick polythene, which can be bought in widths up to 8 meters. Polythene needs extensive reinforcing and is heavier than desirable for its strength, but its availability in huge sizes has the potential to vastly reduce manufacture costs. Future work is further research on materials. If we can achieve a much better weight efficiency the lift capability of the 50m^3 helikite will be more in the order of 60%, or 30 kilograms.

The kite will be strapped to the balloon. This method allows us to use different materials for the kite and balloon, and avoids the problems of glue yellowing in sunlight. Testing has shown the glue bands to be the most visible feature of the transparent Helikite, leading to its detection at increased ranges. Strapping also allows easier repair if one component is a damaged. Finally, we can 'mix-and-match" kites and balloons, using a high visibility opaque kite in training, for aircraft safety, and a transparent kite in operations requiring stealth.

The Phase I work has included fabricating a transparent "Stealth Helikite" constructed of the polythene material. This unit was also used to develop improved methods of attaching the spars for the wings and keel. and testing. Even in bright sunlight the unit was almost completely invisible at 1000 feet altitude.

FIVE METER CUBED STEALTH HELIKITE



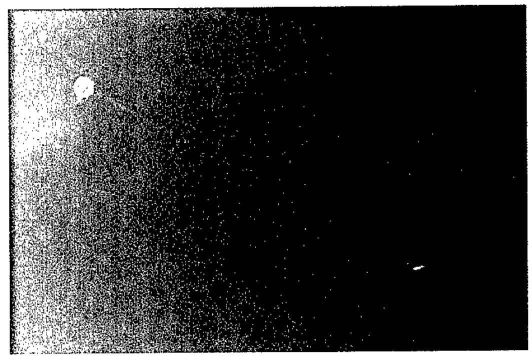


Fig. 4 As Part Of The Phase I Development A Transparent "Stealth Helikite " Was Produced And Tested. The test Article Is Shown On The Left At Ground Level. It Is Very Small At 100 Feet Altitude, On The Right. It Is Completely Invisible At 1000 Feet.

1.2.3 Carrier Until launch the uninflated HEP Helikite is contained in the Carrier body, which is basically an aluminum box approximately 7.5 feet wide by 2.5 feet tall by 8.6 feet long (2.29 by 0.76 by 2.6 meters). The Carrier contains the helium tanks, an electric generator, the tether and a winch to raise and lower the tether (Fig. 5). The box interior contains storage volumes for the sensor package and deflated helikite. The Carrier is mounted on a military standard M116A3 single axle trailer. It also contains eight (8) standard 6.2 m^3 (220 $ft.^3$) pressurized helium tanks of the type used for welding and other military and commercial uses. The tanks are a standard Defense Logistics Agency item. An MEP531A two kilowatt Military Tactical Generator provides power to the payload, the winch and auxiliary equipment.

HEP CARRIER

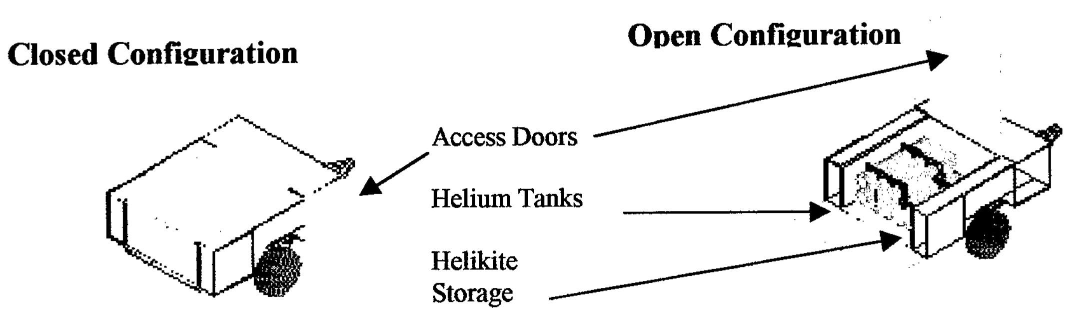


Fig. 5 Carrier The Carrier Contains All Equipment Required To Inflate, Launch And Retrieve The Helikite, Including Helium Tanks, Winch And Launch/Retrieval Mechanism. Guiderails In The Carrier Top Support The Blimp During Launch And Recovery, Preventing Damage And Allowing One-Person Operation.

The Carrier is designed to be towed by a HMMWV or any small truck that can tow the M116 or M101 family of trailers. The complete HEP trailer unit can also be airlifted by helicopters, either internally or as a sling load. This can allow rapid redeployment within an operating zone, or deployment to locations not accessible for a HMMWV, such as a mountaintop, for increased signal coverage.

1.2.3.1 Power Requirements The Carrier will be a standalone unit with its own generator and will require no power from the tow vehicle. The payload power will be specified by CECOM Determining HEP electrical power requirements involved calculating the total power for all equipment, including the winch. Power for the winch is a function of helikite drag and size.

1.2.3.1.1 Electrical Loads The known electrical loads were estimated. The only load known with any certainty was the power for the airborne portion of the payload, which CECOM specified as 400 watts. The remaining loads identified are the ground portion of the payload, safety lighting on the tether and the power for the winch. For a first approximation the ground payload power was assumed to equal the airborne power, or 400 watts. The lighting was estimated at 500 watts.

The major power required is the power for the winch. The winch must be able to retrieve the helikite in wind, which creates a substantial drag load on the tether. The power required will vary with the tether load, the required time to bring the helikite down, and the altitude from which it is being retrieved.

We first estimated the lift and drag of various sizes of helikites to estimate the tether load. This data was used to calculate the tether loads for two wind speeds and the power required to overcome the tether loads for a set of retrieval times. We could then estimate the total power required.

1.2.3.1.2 Drag Calculations Allsopp Helikites has very little data on the lift and drag of Helikites, and most of the data they do have is for small units. However, there is a significant variation of drag coefficients for spheres, or approximate spherical shapes, as a function of Reynolds Number. For that reason the data for small helikites, i.e. at low Reynolds Numbers, may not be applicable to the larger system required for the HEP. We therefore decide to estimate the helikite drag by using data from spheres. Experimental drag coefficients for spheres varies from .07 to 0.5 when referenced to the frontal area. Since we wanted to do a conservative analysis we used the 0.5 value.

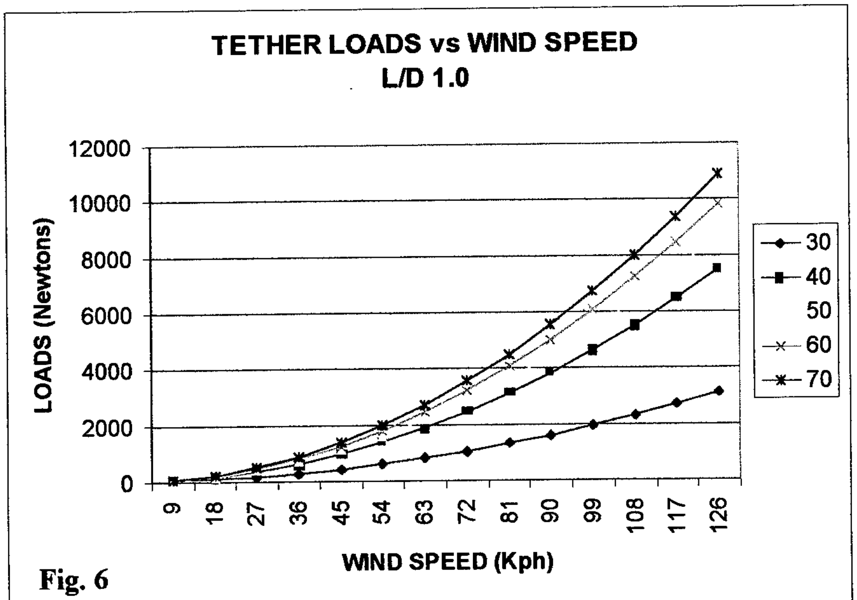


Fig. 6

We calculated the drag for spheres with volumes from 10 to 70 meters cubed over a wind speed range of 2.5 to 35 meters per second (9 to 126 kilometers per hour). The useful payload for these volumes ranges from approximately 5 kilograms for the 10 m^3 helikite to 35 kilograms for the 70 m^3 unit. Helikite test data indicates that they stabilize at approximately 45 degrees in high winds, indicating their Lift-to-Drag ratio (L/D) is approximately one. The lift values were used to calculate the tether loads (Fig. 6).

1.2.3.1.3 Power Calculations Using the tether loads as an input the power required to retrieve the Helikites for various timelines was calculated. Two wind speeds were analyzed. A speed of 45 m/sec (28

mph) covers the regime for normal operations. Wind speeds up to the range should not increase the normal retrieval times. We have established a goal of one hour to retrieve the helikite and prepare for road movement. We wanted to examine the power required to retrieve the helikite in 30 minutes, to allow for deflation and stowage of the system prior to movement.

The second wind speed examined represents a more rare condition where the helikite would have to be retrieved but normal timelines might be exceeded. The primary focus is on having sufficient power to retrieve and stow the helikite to protect if from even higher wind conditions. We selected 72 m/sec (45 mph) as a challenging upper wind speed limit for the system.

The data for the two wind speeds were used to calculate the power required to retrieve the helikite from a 1000 meter operating height over timelines from 5 to 45 minutes. At the contract Kick-off Meeting in January the minimum required HEP operating altitude was stated to be 2000 feet, or approximately 600 meters. We increased this to 1000 meters for the analysis to allow for the angle of the tether in winds, which is approximately 45 degrees. The results of this analysis is in Figure 7.

POWER REQUIRED VERSUS RETRIEVAL TIME

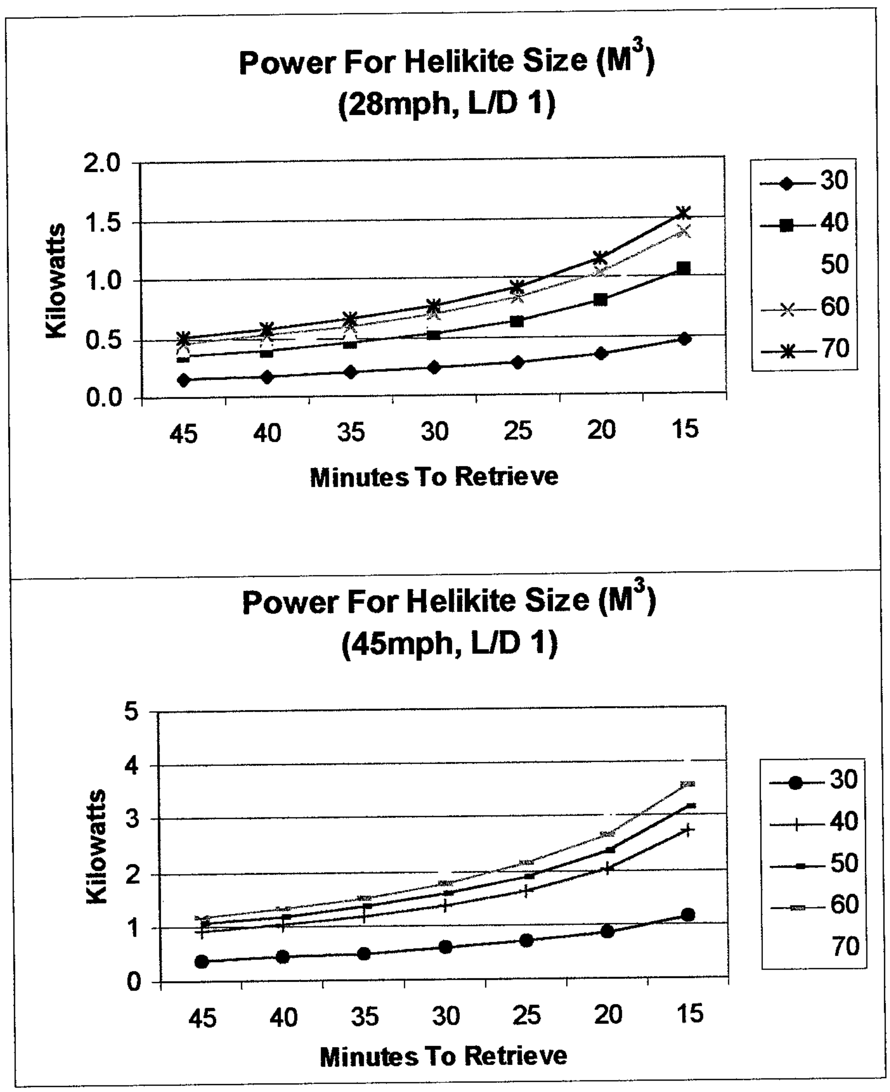


Fig. 7

1.2.3.1.4 CONCLUSIONS: The results can be summarized as follows:

The power to retrieve even the largest helikite examined (70 m^3) at a 45 mph wind speed is less than 3 kW for a time of 45 minutes. Meeting a 30 minute time would require less than 5 kW.

For a more normal operating condition of 28 mph the power is less than 2 kW for a 30 minute retrieval time, for all sizes examined.

The power requirements for the HEP helikite retrieval may be kept under 2 kilowatts for normal operational conditions.

Even under extreme conditions the power requirements may be kept under 2 kilowatts by allowing longer retrieval times.

1.2.3.2 Generator Selection Trade Study We conducted a trade study to define the generator baseline. The Helikite Elevated Platform generator will be a standard military unit from the current designs of the Project Manager - Mobile Electric Power (PM-MEP).

1.2.3.2.1 Ground Rules and Assumptions

The generator must be standard military equipment in current use by the US Army and approved by the Project Manager Mobile Electric Power (PMMEP).

The generator must operate on diesel or turbine fuel.

The generator must provide sufficient power for all the HEP equipment, including the payload, winch and all required items such as tether safety lights.

1.2.3.2.2 Measures Of Merit (MOM) The candidates were evaluated on generator volume, weight, and availability in a variety of military units, and relative cost.

1.2.3.2.3 Analysis Three PMMEP standard units appeared to be suitable candidates and were evaluated:

MEP 5312A	2kW Tactical Quite Generator
MEP 831A / 832A	3kW Tactical Quite Generator
MEP 802A / 812A	5kW Tactical Quite Generator

All three units are of the latest family of generators with reduced acoustics and other emissions. The 5kW is very widely used while the 2kW units are just entering widespread service. A contract for over 4000 2kW units has been implemented. The 3kW unit is still in development.

Initial analysis indicated the total system power required was almost certainly under 5kW, with a high probability that the system could be designed to use under 3kW. Subsequent evaluation indicates that the most probable power requirements are under 2kW.

Since the 5kW unit would be much larger than required, and would take up almost half of the trailer weight capability, we discarded it as an option. We examined options with one or two 2kW units and with one 3kW generator. These options would cover the power range from the moist probable (Under 2 kW) to the high end (4 kW).

The 3kW MEP 831A / 832A is still under development and all dimensions are TBD, except for the weight. To determine if the generator would fit on the trailer we used the dimensions of the 5kW unit for our analysis. The actual dimensions will almost certainly be smaller.

1.2.3.2.4 Mom Evaluation The Measure of Merit (MOM) evaluation is shown in Table I below, with the options rated on a scale of 1 to 5, with 5 being the best. The single dual MEP 531A configuration scored the highest, followed by the dual MEP 531A configuration. The MEP 831A / 832A was the lowest score. However several factors indicate the 3kW unit will improve over time. The actual volume, when defined, is likely to be lower than the 5kW unit. Also the MEP 831A / 832A availability scores will improve as the unit is transitioned into production. The score of the dual 2kW system may go down when the weight and volume of switching and paralleling gear is included. We do not have this defined and could not include it in the MOM analysis.

TABLE I **Generator Comparison**

Configuration	One MEP 531A		Two MEP 531A		MEP 831A / 832A	
Measure of Merit	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
3.1 Volume	6 ft3	5	12 ft3	3	34 ft3	1
3.2 Weight	158 lb.	5	316 lb.	3	325 lb.	4
3.3 Availability in a variety of military units	Coming into wide use	4	Coming into wide use	4	In development, not in wide use	1
3.4 Cost	Lowest of the Options	5	More than twice the single MEP 531A	1	Unknown, but probably more than a MEP 531A	3
Total Scores		19		11		9

1.2.3.2.5 Conclusions

Several Configurations of standard "New generation" Tactical Quiet Generators can meet the system requirements.

The single MEP 531A 2kW design is the most advantageous at this point. It will be our current design baseline. The generator is shown in Figure 8

The MEP 831A / 832A 3kW is an attractive design and will likely become more so as its volume is finalized and it comes into widespread use. It will be carried forward as an option to the design baseline. We will continue to research it for possible use.

The dual MEP 531A 2kW design has a high technical score, and will be reconsidered if the power requirements come in at the high end. However, it is likely to be much more costly and complex.

1.2.3.3 Trailer and Configuration Selection The Helikite Elevated Platform ground equipment, the Carrier, will be designed to be mounted on a standard military single axle trailer towed by a HMMWV. A trade study was conducted to define which standard trailer will be utilized and the configuration of the payload. Several payload options were evaluated, i.e. what generator, how many helium tanks, etc.

1.2.3.3.1 Ground Rules and Assumptions

The Carrier will contain all equipment to inflate and launch the HEP, including helium tanks, winch, electric generator, payload stowage, helikite, and miscellaneous items.

The Carrier will be designed within the constraints of the trailer weight and volume capability.

The Carrier will be designed to fit on the trailer without structural modifications to the trailer.

The trailer candidates must be standard Army equipment in current use or planned for future production.

2kW Military Tactical Generator

Typical Applications

Missile Air Defense Systems

Mobile Kitchen Units

Combat Support Systems

Communications Systems

Nomenclature	DED, 2kW, DC	DED, 2kW, 60Hz
MEP Model Number	501A	531A
NSN	6115-01-435-1567	6115-01-435-1565
Wet Weight	138 lb.	158 lb.
Length	29.5 in.	29.5 in.
Width	16 in.	16 in.
Height	21.8 in.	21.8 in.
Volume	6 Cubic Feet	6 Cubic Feet
Noise at 7 meters	79 dBA	79 dBA
Voltage Connection	28VDC, 2 wire	120 V, single phase, 2 wire

Fig. 8

1.2.3.3.2 Measures Of Merit (MOM) and Data Sources The MOM were the trailer payload volume capability and weight capability. US Army TACOM Trailer data sheets, Project Manager - Mobile Electric Power generator data and Defense Logistics Agency helium tank data were used to calculate volume and weight.

1.2.3.3.3 Analysis The primary trailers examined are the M116A1/A2/A3 and M101A1/A2/A3. Both are single axle trailers attached to the tow vehicle with a lunette. The M116 is a basic trailer chassis with an open frame. It is often equipped with a metal floor and used to mount generators or similar equipment. The M101 is an M116 chassis with a bolt on metal cargo box for use as a general purpose cargo hauler.

It would be desirable from some perspectives to design the Carrier to fit into the M101 cargo body, since this trailer is very widely available and the Carrier could be stored off the trailer until required. It could than be installed on whatever trailer was available. However, this approach has several downsides. The cargo body sides and end restricts access to anything placed inside the body, potentially limiting access to the generator or other equipment. Also, the body weigh reduces the available payload considerably. The M101A3 has an empty weigh of 1400 lb., and a payload of 1760 lb. The M116A3 weighs only 960 lb. and has a payload of 2420 lb.

The M101 and M101A1/A2 have a cargo area approximately 66 inches wide, minus a small cutout for the wheels. The M101A3 has a body width of 73 inches. The wheels have been moved outboard to enable use of the wider body. All versions have a length of 96 inches. The M116 A1/A2/A3 use the narrower wheelbase of the M101 and have the same available cargo length. A custom Carrier body mounted on an M116 A1/A2/A3 could effectively use the entire available width of 72 inches. If the wider wheelbase of the M101A3 were adopted for the M116 the available width rises to 80 inches.

For sizing purposes we restricted the Carrier to the height of the M1010 Bow and Tarpaulin kit, approximately 80 inches. This would ensure that the HEP trailer could go into any area currently accessible by the HMMWV / M101 combination. The Carrier body could probably be made somewhat taller without compromising mobility, since most of the heavy payload (Helium tanks) could be mounted in the lower section. This will keep the center of gravity low enough for adequate slope stability. However, the maximum height for C-130 Roll-On/Roll-Off carriage is 106 inches, and anything approaching that value must be carefully evaluated to avoid contacting the aircraft at the loading ramp breakover point. By restricting the Carrier to 80 inches we have some design margin if we must make the Carrier taller to accommodate the payload.

1.2.3.3.4 Volume Evaluation Our first evaluation was of the ability of the various trailer candidates to contain the volume of the HEP payload. This is a first order analysis, since we did not consider access to the components, nor how the particular shapes of the components would fit into the "box" on the Carrier. For example, the generators may require maintenance access on two, or even three, sides. The helium tanks must be placed so that they can be removed and replaced by the crew without use of cranes or other lifting gear. Likewise, the helium tanks and generators have defined shapes that must be accommodated within the Carrier body. Nevertheless, the analysis can determine whether or not it is possible to carry the volume required.

Table II presents the available volume of the candidate trailers, with the restriction on the total body height of 80 inches. The volume of two configurations, one with parallel 2kW generators and one with a 3Kw generator, were examined. These are the baseline generator configurations identified in the generator study. We used the volume required for 23 helium tanks, the number required to fill a 70m^3 helikite twice, which is the largest size we examined. The volume required ranged from 152 to 183 cubic feet. There is sufficient margin that we are comfortable that any of the candidates can carry the required payload volume.

TABLE II **CARRIER VOLUME ANALYSIS**

Trailer	M101A1/A2	M101A3	M116A1	M116A2	M116A3	M116A3 (Wide)
Body Length (in)	96	96	96	96	96	96
Body Width (in)	66	72	72	72	72	80
Body / Chassis Height above ground (in)	30	30	30	29	29	29
Payload Height (in)	80	80	80	80	80	80
Available Volume (ft3)	183	200	200	204	204	227

1.2.3.3.5 Weight Evaluation Our second evaluation was of the various trailers ability to carry the HEP payload weight. As in the volume analysis, this is a first order analysis. We made rough weight estimates of most components. Two exceptions are the generator weight, which are provided from PM-MEP data, and the individual helium tank weight, which was provided by Defense Logistics Agency.

We used two methods to estimate the body or structural weight. First we calculated an average weight per square foot of body surface, using the M101 steel body as a reference. Second we calculated a body weight based upon the total surface area multiplied by a number that represented an aluminum body of

uniform .25 inches thickness. Obviously that actual body would consist of a thinner skin with backup structural supports, but this approach provides a simple method for a first order estimate.

Table III presents the available payload of the candidate trailers discussed in Section 5 and an examination of various payload options. The are discussed below.

Option One This option includes a steel body similar to the M101 body, i.e. an average weight of 7.1 lb. per ft.^{2}, and helium tanks to fill a 70m^3 Helikite twice. This option is unworkable. The gross payload weight is over twice the trailer payload for all configurations.

Option Two To reduce the weight this option changes to an aluminum body with an average weight of 3.6 lb. Per ft.^{2}, and helium tanks to fill a 70m^3 Helikite twice. This option reduces the weight considerably but is still unworkable.

Option Three This option retains the aluminum body but reduces the helium tanks to a number that would fill a 70m^3 Helikite only once. Although reduced considerably, the weight is still greater than the trailer payload for all configurations. However, it is close to the capability of the M116A1, which has a listed payload of 2840 lb. The structurally similar M116A2 and A3 have payloads of 2040 and 2200 lb., respectively. The difference may be due to the rating system, since the M116A1 is rated for only 15 mph cross-country while the other two are rated at 30 mph. Until we can get a definitive explanation of the difference we are reluctant to accept the M116A1 payload on face value.

Option Four This option retains the aluminum body but reduces the helium tanks to eight (8), the number sufficient to fill a 50m^3 Helikite once. A 50m^3 Helikite is the proposal baseline and provides a lift of 25 Kg in the worst case. The reduction in tanks from 11 to 8 reduces the weight but the gross payload weight is still greater than the trailer payload for all configurations except the M116A1.

Option Five For the remaining options we calculated all the payload and body weight except the helium tanks. We then used the trailer payload capacity to calculate the weight available for the tanks. Dividing this by the tank weight and rounding down determined the number of tanks that could be carried. Option five retains the aluminum body of option four. The number of helium tanks that could be carried varied from one to 10, although the M116A1 number remains suspect. Several of the other configurations could carry sufficient tanks to fill Helikites of 20m^3 to 30m^3 once.

With enough tanks to fill the blimp once there would be several operational options available:

1) The HEP could be emplaced using any available HMMWV or other tow vehicle. The Helikite would be inflated using the onboard tanks. While the HEP was airborne the tow vehicle could deliver a new set of tanks which would be used to replace the empty tanks on the HEP. The HEP could then be moved to another site as required and reinflated from the onboard tanks.

2) Alternately, the HEP could be emplaced using a cargo version HMMWV equipped with a rack of helium tanks. The Helikite would be inflated at the first site using the HMMWV tanks. The HEP could then be moved to another site as required, using any available tow vehicle. Once at the new site the HEP could be inflated using the onboard tanks and the empty tanks replaced.

Option Six This option examined a body of reduced height of 55 inches, which provides approximately 100 cubic feet of volume. This is feasible since we are examining a Carrier with a smaller Helikite and reduced number of tanks. This is sufficient to carry a 50m^3 Helikite and the eight tanks to inflate it. The number of helium tanks that could be carried varied from 3 to 12, although the M116A1 number remains suspect. Several of the other configurations could carry 5 to 7 tanks, which is close to the 8 required to fill a 50m^3 Helikite.

Option Seven This option eliminated one of the two generators and the paralleling equipment, since a smaller Helikite can be retrieved with less than 2kW power. The number of helium tanks that could be carried increased to 4 to 13. Several of the configurations could carry the 8 tanks required to fill a 50m^3 Helikite.

1.2.3.3.6 Conclusions Any of the candidate trailers can be configured to carry the volume of the payload, up to a $70m^3$ Helikite and tanks for two inflation cycles. Volume is not the constraining parameter. Trailer payload weight limits are more serious. To keep the design within the weight limits Option 7 is the preferred baseline for our initial design studies. It has sufficient lift to support the Pseudolite payload and operational flexibility regarding the types of tow vehicles. Since the configurations based on the M116 chassis have greater payload and design flexibility the baseline will use the M116 chassis rather than the M101.

1.2.3.4 Tether Analysis A key element in designing HEP is the feasibility of transmitting power to the payload from the generator on the Carrier. We examined the design requirements, based upon Army inputs on the payload and voltage requirements. In addition to power transmission we also examined whether or not the tether could be used to transmit data to and from the payload, and whether lightening protection is required.

Groundrules And Constraints

The maximum allowed transmission voltage is 416v.

The design goal is to provide 500 watts of power to the elevated payload.

The payload voltage is 28v dc.

No more than 5.5% ripple in payload voltage is allowed.

The total tether length is 1000 meters.

Analysis Results

Power	A 416v tether with two strands of AWG 21 copper wire can supply the required power. It will weigh 7.3 Kg. for the 1000 meter tether.
Lightning	Due to the use of a conductive tether solid state Electro-Magnetic Interference (EMI) filters will be required to protect the payload and the Carrier electrical equipment.
Data	The tether can provide low rate data transmission for status monitoring, but not high data rate for the payload. One or more fiber-optic strands will have to be incorporated into the tether to provide communications to the payload
Other	The Carrier step-up transformer will weigh 10 Kg. The payload solid state AC/DC inverter should weigh approximately 0.5 to 1 Kg.

The analysis indicates that providing power to the payload from the Carrier is feasible. It results in a lighter solution than carrying the power equipment on the payload., particularly for long duration missions. For higher altitudes the weight of the tether becomes significant, and on-board power may be more advantageous.

1.2.3.5 Carrier Body The Carrier body is an aluminum box with compartments in the rear for the helium tanks and racks. These are accessed for installation and changeout by lowering the tailgate (Fig. 9). Two compartments on the sides house the payload and miscellaneous gear. Two compartments in the forward portion house the generator and winch, each reached by its own access door.

The uninflated Helikite is carried in a removable aluminum or fiberglass box mounted above the lower level of helium tanks. A key element of the Carrier design is the provisions to restrain the Helikite during launch and retrieval, permitting one person operation. The Carrier top is hinged on the forward end and can be raised to the vertical to serve as a support for the inflated blimp prior to launch. In this mode the Helikite box is opened and a tarpaulin in the box is draped over the Carrier body, to protect the Helikite from being damaged by any protrusions on the body. The Helikite inflated in place. A slot in the Carrier top engages a key on the blimp keel to provide positive control of the blimp during the critical launch and

retrieval operation. While still constrained by the Carrier top, the Helikite is allowed to rise to the top of the cover. The payload lines are attached and the Helikite can be allowed to rise on its tether.

If required because of overhead obstructions or very high winds the Helikite can be deployed away from the Carrier, using a pulley attached to a ground restraint. In this method the crew lifts the Helikite box and carries it to the launch point. The Helikite is sandwiched between layers of the tarpaulin. A helium inflation line from the Carrier is attached and the Helikite is inflated. It is held down by the upper portion of the tarpaulin until the crew is ready to release it. This allows the crew to launch and retrieve the Helikite even in windy conditions, using the onboard winch to raise and lower the blimp.

PAYLOAD WEIGHT CONFIGURATION OPTIONS

TABLE III

	TRAILER	M101A1/ A2	M101A3	M116A/ A1	M116A2	M116A3	M116A3 (Wide)
	Gross Wt.	2840	3160	3715	2780	3160	3160
	Empty Wt.	1340	1400	875	740	960	960
	Rated Payload	1500	1760	2840	2040	2200	2200
OPTION 1 He Tanks for 2 fills of a 70m3 helikite, Body same as the M101	Total Weight	**4848**	**4935**	**5278**	**5297**	**5297**	**5430**
	Available Payload	-3348	-3175	-2438	-3257	-3097	-3230
OPTION 2 He Tanks for 2 fills of a 70m3 helikite, Body .25 Al	Total Weight	**4203**	**4248**	**4421**	**4431**	**4431**	**4499**
	Available Payload	-2703	-2488	-1581	-2391	-2231	-2299
OPTION 3 He Tanks for 1 fill of a 70m3 helikite, Body .25 Al	Total Weight	**2828**	**2873**	**3046**	**3056**	**3056**	**3124**
	Available Payload	-1328	-1113	-206	-1016	-856	-924
OPTION 4 He Tanks for 1 fill of a 50m3 helikite, Body .25 Al	Total Weight	**2453**	**2498**	**2671**	**2681**	**2681**	**2749**
	Available Payload	-953	-738	169	-641	-481	-549
OPTION 5 Body .25 Al, He Tanks reduced to meet payload limit	Total Weight less tanks	**1328**	**1373**	**1546**	**1556**	**1556**	**1624**
	Available Tank Wt	172	387	1294	484	644	576
	Number of Tanks	1	3	10	3	5	4
OPTION 6 Body .25 Al Ht. 55 in., Tanks meet payload limit	Total Weight less tanks	**1096**	**1131**	**1305**	**1315**	**1315**	**1371**
	Available Tank Wt	404	629	1535	725	885	829
	Number of Tanks	3	5	12	5	7	6
OPTION 7 Body .25 Al Ht. 55 in., One MEP 531A, Tanks meet to payload limit	Total Weight less tanks	**888**	**923**	**1097**	**1107**	**1107**	**1163**
	Available Tank Wt	612	837	1743	933	1093	1037
	Number of Tanks	4	6	13	7	8	8

1.2.3.6 Other Equipment The remaining items in the Carrier are the winch mechanism and equipment associated with the helium tanks. The latter includes the tanks, racks, and tubing for route the helium to the inflation line. The winch has not been selected but our research indicates that several industries produce designs that can be adapted to the HEP requirements. These include the Long Line Fishing industry, which produces winches with several mules of line to deep sea fishing. Another source is

winches used to handle sails on yachts. The long line winches have the capability to hold a kilometer of tether, and are rugged. They are often heavy, so we may have trouble adapting them to the Carrier. Yacht winches use fixed center stanchions, which may make it easier to attach power and data lines since the center of the tether would not move. However, this design can twist the tether, which may be a problem. It may also be possible to adapt readily available and inexpensive automobile bumper winches. These typically do not have the tether capacity required for HEP, but maybe adaptable.

The helium racks were shown in the figure on the Carrier body. The tanks are a standard Defense Logistics Agency item, (NSN 6830-00-782-2656 full, NSN 8120-00-244-6981 empty). The tanks will be stored horizontally and accessed from the Carrier rear. The tanks will be loaded and unloaded on the Carrier by hand. Once in place and locked down, the tanks will be attached to a tubing manifold that will route the helium to a single flexible inflation line.

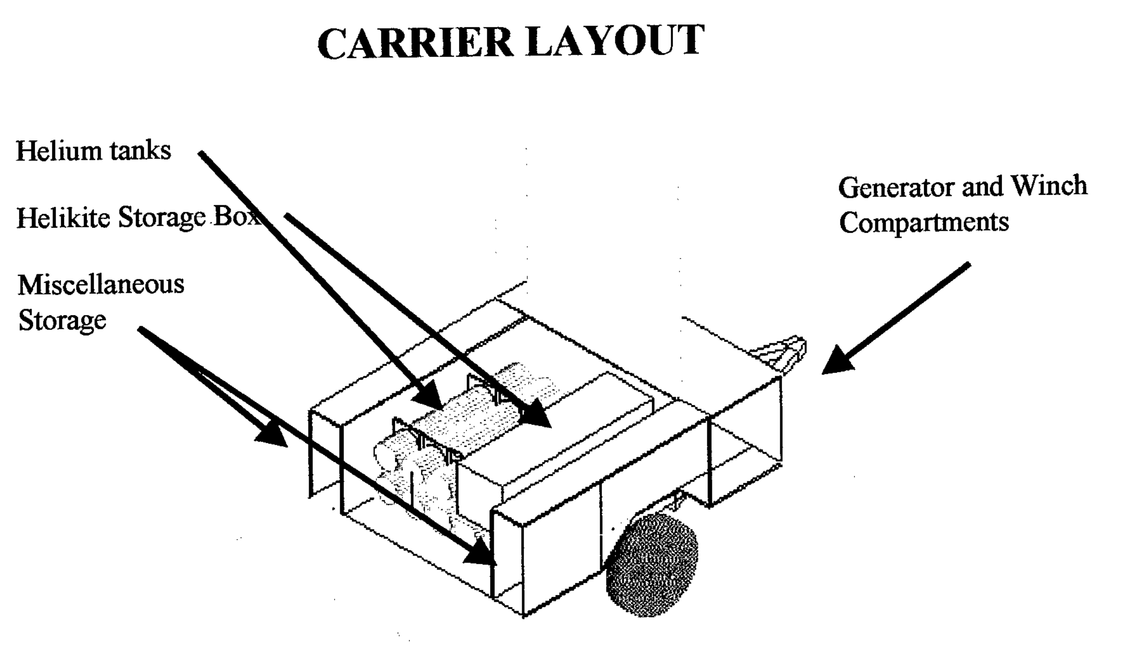


Fig. 9 Carrier Design The Carrier Holds Eight Helium Tanks And A Separate Box For The Helikite. Forward Compartments House The Generator And Winch.

1.3 REQUIREMENTS ANALYSIS CUV's analysis prior to Phase I addressed the primary Army requirements and derived additional requirements we felt were key to system success. These were used to guide the analysis and design efforts in Phase I. The Phase II baseline metes or exceeds all the initial requirements. During Phase I we also conducted a series of trade studies to develop the environmental design requirements.

1.3.1 Operational Requirements Three primary areas (Payload, Mobility, and Endurance) led us to propose a tethered blimp solution to the Pseudolite requirement. Other parameters were examine to ensure a safe, cost effective system could be developed.

1.3.1.1 Payload The basic payload is approximately 70 kg. However, the sponsor stated that the actual pseudolite equipment is approximately 25 Kg., with the remainder being power source, possibly batteries.

By using a tethered system drawing electric power from the ground via the tether, we were able to considerably reduce the size of HEP.

1.3.1.2 Mobility The system needs to be rapidly deployable both to the operational area and within the operations zone. The small size of HEP allowed the system be very mobile and survivable on the battlefield. The small size, simple design and minimum manpower also reduces logistics requirements and transportation / deployment demands.

1.3.1.3 Endurance A Lighter-Than-Air tethered system with few or no moving parts means HEP can provide continuous support for long duration missions. The only limit on mission duration is the need to retrieve the blimp to replace helium leakage. Missions of days or weeks are feasible.

1.3.1.4 Safety The Pseudolite will operate near other military units or civilian areas. It must be safe and have few critical failure modes. A tethered Helikite has almost no failure modes. It does not require power for lift, and even if the tether breaks it will just float away. If required, we can equip it with an automatic deflation device that would vent the helium if the tether is parted. This device would vent the helium rapidly enough that the HEP would descend near the launch point, but not fall so quickly as to constitute a safety hazard to those on the ground.

1.3.1.5 Logistics Manpower is one of the highest operating costs, and greatly affects deployment requirements. With the Army focus on lighter, easily deployed forces we felt the system must be restricted to a two person crew. Additionally, the system must use common fuels and other consumables. It should use standard military equipment as much as possible. HEP uses a two person crew. By designing the system to use a standard trailer and generator unique logistics requirements are avoided. The generator uses standard diesel or turbine fuel. The M116A3 trailer uses standard tires, brakes, etc. the helium tanks area standard military and civilian tank. This not only means the spare parts are in the logistics system but also that the amount of new Technical Manuals and training materials is minimized.

The Army has not decided if HEP will be operated by civilian or military personnel. The actual operations may be a mixture of civilian and military personnel.. For payloads that require extensive contractor support it will be cost-effective to have the entire system operated by civilian technicians. In areas too dangerous for civilian assistance or for payloads maintained by soldiers, operation by military personnel will be the preferred method. By designing the system to use military standard items and Technical Manuals we are leaving either option open.

1.3.1.6 Other Sensors CUV felt that the survivability of the system would be greatly enhanced if the blimp could provide local video coverage of its surroundings. This could help the crew detect hostile guerilla or special operation forces in time to redeploy or call in security support. Additionally, the two-person Pseudolite unit will often be co-located with or attached to other units, for logistics support. Such "add-on" units are rarely welcomed by overburdened field commanders. If Psuedolite could augment their security and provide early warning of attack, most commanders would be much more receptive to their presence. Obviously, such extra capability could not be added if it impacted the basic mission. However, our company research on small UAV systems has identified several very lightweight video solutions that could be applied to HEP.

1.3.1.7 Launch and Recovery To keep up with fast changing Army operations will require the system to be rapidly emplaced and redeployed. We have designed HEP for a launch and recovery time of one hour. Launch time is measured beginning with the system in a road-mobile configuration until the blimp was fully deployed. Retrieval begins with blimp at operating altitude and ends with the system in a road-mobile configuration ready to move.

1.3.2 Survivability Although not addressed in the SBIR topic, we felt that survivability is an important consideration for any system. In today's operational environment there are no safe rear areas. The system will remain in one location for long periods of time, and may attract enemy attention. HEP will operate in the rear Divisional area, so the primary threats are aircraft or helicopters attacking the Helikite, and

artillery or standoff weapons against the Carrier. There are two aspects to be considered: survivability of the HEP Helikite itself and detectability of the launch vehicle location. If detected the Helikite is survivable under most attack scenarios except close-in air attack. With its minimal signatures, normal IR and radar guided weapons will not lock on to the Helikite except at very close range. With a pressure differential of only a fraction of a psi, the Helikite will not suddenly deflate if torn or punctured by a few bullets. The non-flammable helium cannot explode or burn, so a damaged blimp would merely slowly descend over several hours or days. It can easily be patched and reinflated. Obviously, heavy machine gun fire from an attack helicopter at close range could shred the both Helikite and payload and destroy the system. HEP will operate far enough from the front line to make this type of attack uncommon.

We have designed HEP to have minimum visual, radar, acoustic and Infra-Red signatures to reduce long range detection that would permit standoff missile attack. The Helikite will be constructed from radar transparent material, making it exceedingly difficult to detect by radar. Its Infra Red signature is very small. Virtually its only signature is that the blimp will be visible on the horizon in daylight. There are potential countermeasures to diminish this signature. In Phase I we built and tested a Helikite made of transparent material. It is almost invisible at a range of a few hundred feet.

Several techniques to reduce the Carrier detectability will be used, primarily a camouflage kit consisting of standard netting with quick fold-out supports. This will allow the crew to quickly conceal the vehicle once the Helikite is launched. The Carrier generator will have acoustic and IR suppression. Once the Helikite is launched the remote tiedown system may be employed to attach the tether to the earth several hundred feet away from the Carrier. The tether can be connected in a field or street and the Carrier concealed in a building. In rural terrain the tether might be attached to the ground in a field but the Carrier could actually be several hundred feet away hidden in a grove of trees.

1.3.3 Operational Requirements Summary The initial requirements for the Helikite Elevating Platform, and the status of the Phase II Baseline in meeting these requirements, are outlined in Table IV. All requirements are meet or exceeded.

1.3.4 Natural Environmental Requirements Analysis was conducted to determine the HEP system environmental requirements. The analysis is based on designing HEP for deployment to severe, but not the most extreme conditions. However, HEP will be designed for deployment to all probable operating theaters. Values for key parameters were identified that would support realistic HEP deployment scenarios without being so demanding that the system is unaffordable. The goal is to strike a balanced set of realistic requirements to support deployment to all likely operational areas. A particular concern is to not impose requirements that would make the system larger and heavier than necessary, since that negatively impacts booth strategic and tactical mobility. We also wanted to avoid any requirements that would drive us away from using normal commercial materials and parts. Using military generators and trailers for HEP ensures ruggedness for field operations and simplifies logistics. However, for other components we want to use commercial hardware wherever possible to reduce cost.

All parameters were identified in two categories: Endure and Operate. Further, we identified threshold values and desirable Goals for each parameter.

1.3.4.1 Data Sources And Analysis MIL-STD 210 is the primary data source used to develop the HEP natural environment requirements. Additional data came from the WORLDBATH Topographic Database from the University of Michigan and Columbia University.

1.3.4.2 Low Temperature The low temperature values selected are -32°C (Endure) and -21°C (Operate) for both the Threshold and Goals. These numbers are the one percent low temperature extreme for the Basic regional climate type identified in section 5.2 of MIL-STD 210. This excludes the Severe Cold region of northern Canada and Siberia and the Cold region of northern Russia, Mongolia, northern China, Canada and central Alaska. A portion of North Dakota and Minnesota are also included. Of the excluded areas. only Canada and Alaska are likely deployment areas. Note that the specified temperatures do not

mean HEP could not be used in these areas, only that it could not operate in the most extreme portions of the winter.

1.3.4.3 High Temperature The high temperature values selected are 49°C (Endure and Operate) for both the Threshold and Goals. These numbers are the one percent high temperature extreme for the Hot regional climate type identified in section 5.2 of MIL-STD 210. This includes the militarily significant regions of the Sahara and Middle East.

1.3.4.4 Humidity Topical regions often experience prolonged periods of 100% humidity, so this is an appropriate requirement for HEP

TABLE IV **HEP REQUIREMENTS**

AREA	ARMY REQUIREMENT	HEP PHASE I REQUIREMENT	HEP PHASE II BASELINE
SPECIFIED REQUIREMENTS			
Height	100's to 1000's Meters	Same	1000 meters
Duration	Longer Than Hours But Less Than Weeks	Operate One Week Without Downtime	Met
Payload	70 Kg. With Power		
	20 Kg. Without Power	Power Via Tether	Met
Mobility	Mobility Is Paramount	Standard Trailer Towed By HMMWV	M116 Trailer Version Towed By HMMWV
	Rapidly Deployable	Standard Transport	Met
System Operator	Soldier Or Civilian TBD		Designed For Military
Operating Location	TBD		100 KM From Frontline
Power	500 Watts	Same	2 kW Generator
Environmental	Wind Conditions Are Important	Threshold 30 Kts., Goal 50 Kts.	See Environmental Table
Stability	Fairly Small And Slow	Stabilizing Wings	Met
Sensor Package	Pseudolite	Same, Plus Video	Met
DERIVED REQUIREMENTS			
Surviability	Not Specified	Minimize Visual, Radar, IR, Acoustics	Tactical Quite Genertator, Transparent Helikite
Logistics	Not Specified	Two people maximum	Met
Other Sensors	Not Specified	Video Surveillance	Met
Launch and Recovery Timeline	Not Specified	One Hour Required, 1/2 Hour Desired	Met

1.3.4.5 Wind Speed It is impossible to design equipment that could operate in all wind conditions, since hurricanes, tornadoes and other storms can generate extremely high winds. In these instances the HEP would have to be stowed and tied down if outdoors. Even then it could not sustain a direct hit by a tornado or intense hurricane. Even large trucks can be overturned by hurricane winds.

Excluding these storm winds, it is prudent to set the HEP wind requirement at the 1% sustained point for the windiest region, northern Scotland. It could be argued that this is a rather extreme value and that some lower value, perhaps the 5% point, could be used. However, it should be noted that the ground equipment in its stowed condition will be towed on the highway, so it must withstand high relative winds due to vehicle motion. Furthermore, winds above ground are often higher than at ground level. Since the

airborne Helikite will be exposed to these higher winds, we felt it reasonable and prudent to use the 1% value. The wind speed required is 22 meters/sec (49 mph) for both Endure and Operate.

1.3.4.6 Rainfall Intense rainfall is quite common in tropical areas, so we selected the .5% value recorded in several tropical regions. This value, .6 mm/minute, is for the ground equipment, the Helikite and its payload.

1.3.4.7 Hail Although large hail is a relatively infrequent phenomenon, it can damage equipment. The most severe measured location with good data, Cheyenne Wyoming, has an average of 9 hail events each year. Because of this infrequency and the great variability in hailstone size MIL-STD-210 recommends using a long term probability value for design purposes. We chose a .1 % value for the hail requirement for the ground equipment to endure. This is value is 20 mm diameter hailstones at a 58 meters/sec impact velocity. We did not find sufficient data to assign a hail requirement to the airborne equipment.

1.3.4.8 Operating Altitude (Ground Equipment) HEP must be capable of deployment to likely crisis / war zones around the world. The maximum operating altitude of the ground equipment is one of the most critical parameters in determining where the system can operate. As already noted, it is impractical to make the system capable of operation in all climatic extremes. However, it must be usable in realistic scenarios.

To define the operating altitude we used the WORLDBATH data base that documents the elevation distribution of the world's surface. The Histogram in Figure 10 is taken from this source. It demonstrates that portion of land above a given elevation declines rapidly to approximately 2000 meters above sea level. It then remains fairly constant until 3000 meters and then declines again. Since the 3000 meter level is a break point in the histogram and altitudes above this level are rare, we felt it reasonable to use the 3000 meter level as our maximum HEP operating altitude.

Using the 3000 meter level we conducted further analysis of the worldwide deployment capability of HEP. For this we used an interactive version of the WORLDBATH database that presents the worldwide distribution of elevation. By setting the lowest altitude to 3000 meters we obtained a worldwide map of all regions that were above that elevation. The scale of the database meant that an isolated mountain peak above that level would not show up. However, any large area where all elevations were above the 3000 meter level would be presented.

Only four large areas of the world are above the 3000 meter level: the interior of Antarctica, the Greenland icecap, the Himalayan plateau, and the central Andes mountains. Of these Antarctica, the Greenland icecap are extremely improbable deployment areas. The Himalayan plateau is controlled by China, India, Afghanistan, and Pakistan. None of these nations is likely to invite a US military presence, particularly a ground based system.

Of the regions above 3000 meters, the only likely deployment area is the Andes. The inset in Figure 10 shows the extent of the region above 3000 meters. Designing HEP to operate in this region would require a significantly larger system, reducing ground mobility. However, we could accommodate this altitude by designing a kit to be used with the basic system if deployment were required to a high altitude region. This kit would consist of an additional Helikite to be attached to the primary HEP tether to provide additional lift. This additional Helikite could be inflated from tanks on the tow vehicle.

From this analysis we recommend a operating altitude of 3000 meters (9843 feet), with an optional kit for higher altitudes. It should be noted that this is the Operating pressure condition. The minimum non-operating Endure pressure will occur during deployment in unpressurized cargo aircraft.

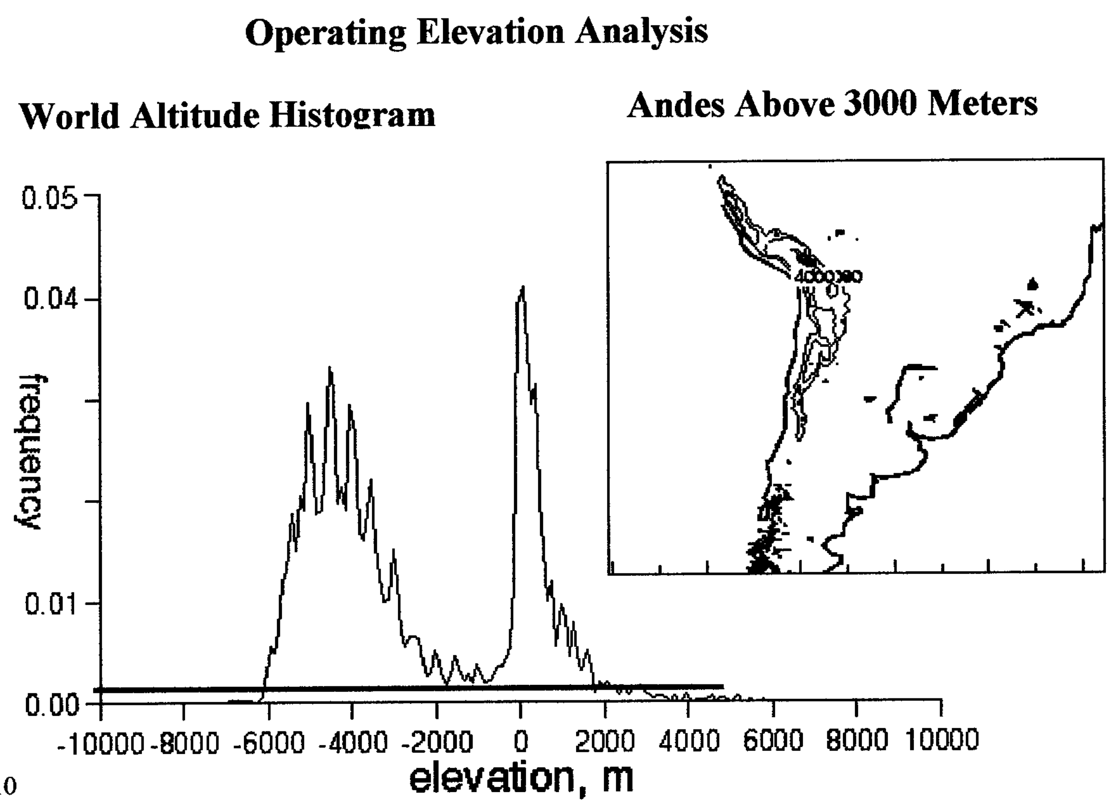


Fig. 10

1.3.4.9 Operating Altitude (Airborne Equipment) HEP is required to deploy 2000 feet (610 meters) above the ground. For design purposes we specified a tether length of 1000 meters. In wind Helikites typically fly at an approximately 45 degree angle, so the 1000 meter tether would provide an altitude of 707 meters (2320 feet). However, in zero wind the tether would allow the Helikite to rise to 1000 meters above the Carrier. Therefore, if the ground equipment is at a maximum operating altitude of 3000 meters the airborne equipment must operate at 4000 meters.

1.3.4.10 Low Air Density Air density is of critical importance to a Lighter Than Air system. Periods of lower density can occur frequently in hot regions. We selected the 1% extreme low density values corresponding to the required operating altitudes already discussed. At the higher operating altitudes this is an approximately 8 to 10 percent lower density than a Standard atmosphere. Changing the value to the 10% probability chart would only add about 1% to the density, so we elected to use the 1% values.

1.3.4.11 High Air Density We have not identified any design functions that would be impacted by high air density. However, it is included for completeness. The value recommended is the 1% extreme.

1.3.4.12 Sand and Dust Sand and dust is both a natural and a man-made condition. MIL-STD-210 recommends using the observed values due to material thrown up by helicopter blades for most military equipment. This value, 2.19 gm/cm^3, exceeds natural conditions by about seven times.

1.3.4.13 Conclusions Table V presents the proposed Natural Environment limits for HEP development.

TABLE V

NATURAL ENVIRONMENTS

		THRESHOLD		GOAL		MIL-STD-210 REFERENCE
Parameter	Units	Endure	Operate	Endure	Operate	
Low Temperature	(Deg C)	-32	-21	-32	-21	5.2 (a)
	(Deg F)	-26	-6	-26	-6	
High Temperature	(Deg C)	49	49	49	49	5.2 (b)
	(Deg F)	120.2	120.2	120.2	120.2	
Humidity	%	100	100	100	100	5.1.6.1
Wind Speed	m/sec	22	19	22	22	5.1.10.2
	mph	49	43	49	49	
Rainfall	mm/min	0.6	0.6	0.6	0.6	5.1.11.2
	in/min	0.02	0.02	0.02	0.02	
Hail	mm dia	20	TBD	20	TBD	5.1.15
(Ground Equipment)	m/sec	58	TBD	58	TBD	
	in dia	0.8	TBD	0.8	TBD	
	ft/sec	26	TBD	26	TBD	
Operating Altitude	Meters		3,000		3,000	
(Ground Equipment)	Feet		9,843		9,843	
Operating Altitude	Meters		4,000		4,000	
(Airborne Equipment)	Feet		13,124		13,124	
Low Density	kg/m3		0.82		0.79	5.1.19.2
(Ground Equipment)	Slug/ft3		0.00159		0.00153	
Low Density	kg/m3		0.79		0.71	5.1.19.2
(Airborne Equipment)	Slug/ft3		0.00153		0.00137	
High Density	kg/m3	1.72	1.72	1.72	1.72	5.1.18.2
	Slug/ft3	0.00334	0.00334	0.00334	0.00334	
Sand and Dust	g/m3	2.19	2.19	2.19	2.19	5.1.21.2
(In rotor downwash)						

1.4 BASELINE DESIGN SUMMARY CUV's HEP design combines several innovations to meet both military and civilian surveillance requirements in one simple and cost effectiveness system. The semi-rigid air vehicle provides better mounting for sensors than traditional blimps, and facilitates launch and retrieval. The Carrier is small enough to fit on a standard military trailer and is highly mobile when towed by a HMMWV. It is rugged enough to withstand military operations while the Helikite restraint design permits one person operation even in heavy winds. HEP is much smaller, lighter and easier to operate than any competitors. Due to its simplicity and minimal components HEP has a projected production unit cost of under $35,000, exclusive of the payload and GFE.

The Phase I work has developed a HEP design that:

* Provides long term, low cost continuous Pseudolite coverage of critical areas,
* Provides safe, effective operation by one person,
* Is based on current technology and components to minimize cost, and
* Has significant commercial potential to support economic production.

2.0 OTHER POTENTIAL APPLICATIONS AND MARKETS HEP will provide a unique and cost effective overhead capability for users of the pseudolite or similar payloads, such as Differential GPS transmitters. The basic HEP design is adaptable to a number of military and civilian users who could employ the Helikite and Carrier for other payloads. Some of these s applications can use the Pseudolite HEP without modification will be the focus of our near term marketing. Others will require partnering with other companies to develop the payloads. The main usage categories are law enforcement and private security companies, military / peacekeeping, and communications. These additional missions will increase the production base for the HEP and lower unit acquisition costs.

2.1 NAVIGATION OR SIMILAR PAYLOADS Phase II will complete the HEP design for Pseudolite and related uses such as Differential GPS transmitters. There are a variety of commercial applications that could use an elevated pseudolite to improve navigation and avoid GPS blind spots. The FAA is in the first stages of deploying an Instrument Landing System at smaller airports that will use ground based psuedolites.

The helicopter industry is promoting a similar GPS based "free flight" Air Traffic Control (ATC) system to maximize helicopter operations under instrument flight conditions. However, helicopters must operate in many more dispersed areas than aircraft, requiring a helicopter ATC system with continuous availability and resistance to jamming, either inadvertent or deliberate. HEP may be part of the answer to providing this helicopter ATC system, particularly in urban areas where concrete high rise buildings block satellite GPS signals.

In a related area, the Unmanned Air Vehicle industry is pushing for FAA rulemaking on UAV operations in civilian airspace that would also rely heavily on GPS. HEP coverage may be key to convincing the FAA to allow routine unmanned operations in civilian airspace.

2.2 MILITARY AND PEACEKEEPING MISSIONS A design based upon HEP but with a video and/or Infra-red surveillance payload would allow a substantial reduction in manpower required for rear area security of large facilities such as airfields and logistics points. It can augment coverage along the perimeter and in interior areas such as command centers, munitions storage, etc. to detect saboteurs and unconventional forces. HEP can improve early warning coverage and allow proactive patrolling by the security force rather than static guard duty. HEP overhead viewpoint would permit the security force detect and track ground attackers who had penetrated the defensive perimeter. It would also help the commander make a rapid post-attack damage assessment, to direct firefighters and medical personnel to critical areas. HEP would both free infantry for offensive missions and reduce the in theater logistics burden.

HEP can also provide a method to monitor ceasefire/armistice lines and similar peacekeeping roles. HEP could not only provide low cost, long term surveillance to ensure against ceasefire violations but also provide complete unclassified video records of which party instigated any violations. The video could be released to all the ceasefire parties and the news services, potentially deterring ceasefire violations. Since HEP is an unclassified, low technology system and is ground based, it can be inspected by the host nation to ensure that only allowable sensors are being used. This may be more acceptable to many nations and ceasefire parties than reconnaissance aircraft overflights.

2.3 LAW ENFORCEMENT / SECURITY Both police and commercial security companies could use the video surveillance version of HEP to augment crowd control/security at major events such as concerts and fairs. HEP can provide feedback directly to the police on the scene and to a central dispatcher/monitoring point. This would greatly enhance the police coverage of such events, and allow concentrating officers at key points. HEP could assist fire and emergency rescue personnel in control and assessment of activities at major fires and similar emergencies.

Law enforcement agencies such as the Border patrol or Customs could maintain constant 24 hour overhead wide area surveillance coverage of border crossings, airports, docks etc. HEP could also provide anti-terrorism surveillance at critical outdoor events such as Presidential visits.

2.4 COMMUNICATIONS PAYLOADS The HEP has sufficient payload to act as an airborne communications platform. One use would be as a communications relay for scattered ground units, particularly in mountainous or urban terrain. It could also be an excellent relay to airborne UAVs, at much less cost than using a second UAV to maintain linkage.

A civilian communication version of HEP could substitute for a cellular phone tower to increase local capacity during major events such as golf tournaments, etc. In interviews National Guard personnel have suggested a version of HEP carrying a cellular phone relay equipment. Cellular towers are sometimes knocked out by hurricanes, earthquakes or tornadoes, or their power is lost. More importantly, the emergency response communications are disrupted because every mobile phone user is calling their family, friends and bosses to report their situation.

2.5 OTHER PAYLOADS A version of HEP could carry tactical jamming equipment. One particular application is the SEPS jammer, used to cause premature detonation of incoming mortar and rocket warheads. By jamming the proximity fuses, really small radar systems, SEPS causes the warheads to detonate well above the ground, where the fragments are far less dangerous. HEP could raise the jamming antenna to several hundred feet above ground level, greatly enhancing the SEPS protected area from each antenna. It also places the antenna above masking by buildings in urban areas.

Other payloads could include tactical jammers for enemy communications and radars. The advantage of HEP over other jammer platforms is the ability to deploy for long duration missions, the ability to be "wait" in a dormant mode for long periods, and, in some instances, to be expendable. Unlike manned platforms, HEP will not attract anti-radiation missiles to a manned vehicle.

HEP could make an ideal tactical COMINT / SIGINT platform. In peacetime it could be deployed along areas such as the border in Korea or Kuwait and provide continuous intelligence coverage up to 60 miles into hostile territory. A potential enemy may shut down their communications and signals for short periods to deny information to our reconnaissance satellites or aircraft. They cannot shut down operations for the days or weeks that HEP could monitor them. In war or contingency deployment operations the mobile HEP could supplement ground based COMINT / SIGINT platforms. It could not redeploy as rapidly as HMMWV mounted systems but would have a far wider coverage area.

Research payloads could be used for environmental atmospheric research, providing long term monitoring of wide area pollution transport. Many pollution scenarios require data on movement of the air at hundred or thousands of feet, but most data is limited to ground sites. Aircraft can provide "snapshots" of pollution movement but only HEP could monitor long term situations. Since tens of millions of dollars in pollution control equipment, or even decisions on the siting of new factories, are depended upon the proper modeling of pollution flow it is critical to provide good data.

In a related area, laser propagation and related atmospheric research is required to support the ballistic missile defense program. Again HEP is an ideal platform for this research.

3.0 COMMERCIALIZATION STRATEGY We have developed a comprehensive plan to market military and civilian versions of HEP with a variety of payloads. We can bring several versions to market within two years. HEP basic simplicity and the focus on modular design should allow it to be manufactured at relatively low cost with minimum capital investment.

3.1 MARKET FUNDAMENTALS The overall marketing plan for HEP is based on the following fundamentals:

Our market consists of a limited number of customers who are organized in a complex bureaucracy,

Military and civilian markets have unique characteristics that require different marketing approaches, and

There are no dominant market leaders in any of our focus areas.

3.1.1 Market Segment CUV concentrates on systems that are smaller than existing methods of accomplishing the same mission. In some cases this means a completely new type of product, such as the HEP, which is much smaller than any comparable military tethered blimp. In others it means substituting smaller unmanned vehicles for manned aircraft, or designing a smaller UAV to perform missions now accomplished by larger UAVs

The major market segments are the US military services, particularly the Army and the Marines, and law enforcement agencies such as state Highway Patrols, the Border Patrol and the Drug Enforcement Agency. The majority of sales will be handled by direct sales to the federal government. A minority of sales will be to state law enforcement agencies and commercial security companies.

CUV's product development approach has created several distinct advantages over any competition. Our products are typically smaller, lower cost and have fewer logistics requirements than competitive methods to accomplish the same missions. In the case of HEP no other small blimp systems use the Helikite technology. Allsopp Helikites Ltd. has sold a few medium sized Helikites as research tools, but no other militarized mobile systems exist or are in development. HEP represents a significant improvement over any other system for maintaining medium weight payloads aloft for long periods of time.

3.1.2 Market Definition The Helikite Elevated Platform (HEP) is a totally new approach to lifting communications and surveillance payloads and so there is no existing market. Currently these payloads are lifted by helicopters or aircraft costing $500 to $1,000, or more, per hour to operate. Alternately, ground based systems are placed on mountain tops or high buildings. Both methods are expensive and require many people. HEP will be much less expensive, require a minimum crew and provide days of continuos operation rather than hours. As detailed in Section 2.0, HEP can carry a variety of payloads and be used for a number of military and civilian missions.

3.2 CUSTOMER PROFILE Our primary customers are the military and state agencies who function in a highly regulated procurement system. Decisions to purchase are almost always made by committees, often separate and technical and cost review panels. The system involves many organizations and is driven by budgets and user requirements rather than Return-On-Investment or consumer preferences.

3.2.1 Military Customers The military system functions by user organizations developing requirements documents that are then passed to the developmental commands. The development commands create projects to conduct research on the methods to meet the user requirements. If successful, these small research projects can lead to developmental programs. In turn successful development and testing can lead to approval for production of the final product. The final products are then supplied to the User Commands, along with training materials, support equipment and spare parts.

Our current customer, US Army Communications and Electronics Command (CECOM) is planning to use our product for carrying a Psuedolite payload which mimics a Global Positioning System (GPS) satellite. Other CECOM offices have requested information about using HEP to carry a communications relay system to control long range UAVs beyond the line of sight of ground control systems. For HEP, CECOM will be the major actor up to field testing of prototypes. At that point the Army Training and Doctrine Command (TRADOC) will become the likely user representative. TRADOC is involved when items will be used by a number of different units within the Army.

Other potential HEP customers include the Air Force, which has requested proposals for a system to elevate atmospheric research instruments in support of missile defense programs. The Army Program

Manager for Unmanned Ground Vehicles (PM-UGV) is experimenting with large aerostats as communication relays to control battlefield unmanned ground vehicles. HEP is much more mobile and less costly than the large aerostats, so we intend to market it to the PM-UGV. A communications relay version of HEP would fit into new Marine Corps concepts for widely distributed fast moving combat units, but we have not yet identified the potential users within the Marine Corps.

3.2.2 Civilian Customers Federal law enforcement agencies such as the Border Patrol or Customs could use the communications relay version of HEP to maintain contact with remote units. They could use a surveillance version to maintain constant 24 hour overhead wide area surveillance coverage of border crossings, airports, docks etc. HEP could also support anti-terrorism surveillance at critical target facilities or to cover outdoor Presidential events. We believe these uses will make federal law enforcement a key HEP customer once we have demonstrated its capability.

We view state law enforcement agencies such as the Highway Patrol and Emergency response agencies as potential customers for a surveillance version of HEP. The National Guard is a special case, since they have both federal military missions and state disaster support duties. This means they also have multiple sources of funds to procure equipment. Police and commercial security companies could use a surveillance version of HEP to augment crowd control/security at major events such as concerts and fairs, allowing better manpower utilization. Commercial security companies with contracts covering large facilities such as nuclear power plants may use HEP to reduce their manpower costs., providing a strong Return on Investment.

3.3 RETURN ON INVESTMENT AND POSITIONING Developing a commercialization plan requires an understanding of the customer's Return on Investment (ROI) by using the product. The ROI may involve monetary savings, ability to use lower cost manpower, or manpower that is easier to recruit and train. It may also involve opening a new operational capability, or reducing the logistics burden. Once the ROI is understood the product can be properly positioned in the market and a marketing strategy developed.

The major benefit of HEP is an improved capability for overhead surveillance, or the elevation of electronics, at a fraction of the cost of manned aircraft or helicopters. The system uses less skilled manpower and has lower acquisition, training and operating cost than competitive systems. Its logistics burden and airlift requirements are far less than other methods of accomplishing the same missions. Additionally, HEP can operate in environmental conditions that are too dangerous for manned aircraft operations.

3.3.1 Military ROI For military customers, HEP will pay for itself by reducing their need for expensive helicopters and aircraft. For example, a HEP can be procured for less than the costs of 50 hours of helicopter operating time, not even considering the helicopter's procurement cost of several million dollars. Furthermore, HEP uses a two person enlisted crew who do not require expensive training. An aircraft or helicopter for the same mission will require a crew of two Warrant Officers or two Commissioned Officers. Each pilot requires initial training costing more than a million dollars, and requires ten or more flying hours monthly just to maintain minimum proficiency.

To be effective against jamming a minimum of three, and preferably four or five psuedolites must be used simultaneously. The Army wants to have them immediately available for days at a time. Because of limited flying hours per day and required maintenance providing this coverage would require at least ten, and probably 15 helicopters per division. Psuedolite can be carried by older helicopters, so it is reasonable to discount the procurement cost. However, the pilot proficiency training time alone, without even counting the pilots salaries, will cost from 2.4 to 3.6 million dollars per year per Army Division. In contrast, a Division set of HEP can be procured for less than $400,000. It can be operated for less than $50,000 per year per Division. The direct monetary ROI is better than 20 to 1 per year, without even considering the reduced airlift and other logistic considerations.

3.3.2 Civilian ROI Typical civilian ROI is similar. For example the NC Highway Patrol operates two helicopters in shifts to maintain 8 to 12 hour coverage of each of the six NASCAR races held in North Carolina each year. A surveillance version of HEP can cover an entire week of race qualifying, partying and the actual race day activity for less than the cost of one shift of helicopter operation.

3.3.3 Positioning Based upon the ROI analysis, HEP will be positioned as an enabling technology to with a high monetary ROI and as a product that permits totally new activity or completely new methods to perform difficult tasks. HEP's unique advantages in terms of lower costs, smaller size, greater capability and improved ability to operate in harsh conditions will be exploited to position it in the customers' minds as the preferred product.

The military conducts rigorous reviews of production cost before agreeing to a contract, but they are willing to pay for performance and reliability in their harsh operating conditions. Failure in the field costs them lives, not money, so they will pay for the quality products they need. Although we have developed cost-effective solutions to manufacture HEP there are some requirements that will drive cost of the military versions. These include cost of high mobility trailers and standard military generators, as well as designing for adverse world-wide environments.

Civilian customers are more price conscious, so we anticipate developing simplified versions of HEP for some civilian markets. A rule of thumb presented to us by several police departments is that they have trouble justifying anything more expensive than a police cruiser. Civilian versions can use lower cost trailers and commercial generators. There are probably cases where civilian users will lease rather than purchase HEP.

The Helikite Elevated Platform, due to our efforts to develop a small, cost-effective trailer and blimp design, will continue to provide the lowest cost, most mobile mission capability while using minimum manpower, compared to all competitors.